A new permanent multi-parameter monitoring network in Central Asian high mountains – From Measurements to Data Bases

T. Schöne, C. Zech, K. Unger-Shayesteh, V. Rudenko, H. Thoss, H.-U. Wetzel, and A. Zubovich

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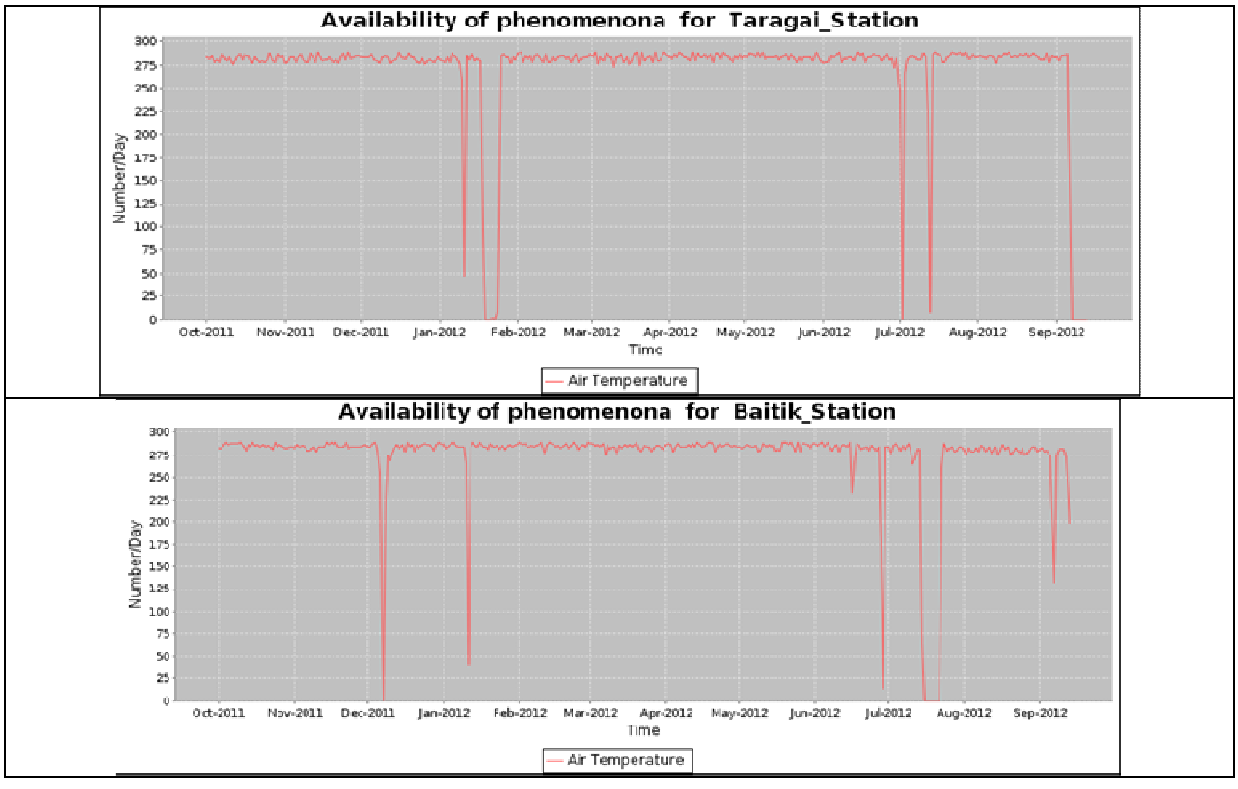
Reply & Comments for: Anonymous Referee #2
The Reviewer's comments are in bold & italic.

In this paper the technical setup and the data handling for a network of automated so called multi-parameter stations in Central Asia are described. The work described in the manuscript is of an applied nature: Solutions for operating unmanned remote multi-parameter stations and to efficiently handle the large amount of diverse data have been developed and are applied at the example of a station network in central Asia. The manuscript gives a very good overview to the technical side of the installations and the data management. To my opinion this manuscript provides valuable detailed background information to the design and operation of automated and remote weather (and other parameter) observation systems. Adding information on the following two topics would complete the good technical description:

(1) On page 316 line 3 it is stated that the stations show excellent performance. I believe that some clarification of the station performance is missing:
Why is the performance excellent?

Our internal performance indicator is the data return rate. The following additional graphs show the observations per day for a period of one year and the example of air temperature measurements. Nominally, with a 5 min sample interval, 288 observations per day and parameter are expected. The graph clearly shows that only minor outages occurred. The performance is identical for the other parameters, except if a sensor is broken.
We will add an additional explanation to the revised manuscript.



Have there been any technical issues during the three years since the installment of the first two stations?

The sensor selection has not changed much over time. Only the radiation shield of the air temperature sensor at KEKI station had to be replaced by an intact ventilated shield.

In addition, we have increased the number of solar panels and batteries from four to six to better perform during deep temperatures and short solar input in winter times.

In recent installations (after paper submission) in hot environments with day time temperatures of 45°C and above,one station had difficulties to handle inside temperatures of more than 60°C and CPU board temperatures of up to 80°C. Currently, we are evaluating the station performance at high temperatures in the controlled environment of a special climate chamber in the lab. Individual electronic components are being tested for their maximum operating temperatures and will be replaced as soon as the sensitive component has been identified. In the mean time, the operation of the VSAT modem is limited to night times, if the inside temperature is above 40°C.

Which parts performed well and which parts/components/protocols caused problems and how were these addressed? I believe that such information is essential and would further improve the value of the detailed technical descriptions.

Since the ROMPS concept is based on previous experience, only little had to be changed.
- For the snow measurements we have moved from snow pillows to SPA, which is expected to bring advanced information.
- We have developed downloading software for the Campbell CR1000 recorder which now also allows remote re-configurations.
- A drawback is the maintenance of the rain gauges. The filter mesh inside the sensor needs regular cleaning, which cannot be performed regularly for remote locations.

(2) Information on the maintenance of the stations is missing. How often are these visited? Who is doing the ordinary/extraordinary maintenance (local experts/foreign specialists)? The authors also provide very little details on installation procedures. A (very brief) description might be of added value.

All stations have varying maintenance interval, which is defined rather by opportunity than by clear cycles. Generally, maintenance should be carried out annually (e.g. the filter for the tipping bucket needs regular cleaning). However, in the past, some stations have been operated unattended for (up to) two years without major service disruption.

The CAWa project is accompanied by a training programme, where specialists from CA countries are trained in station maintenance and trouble shooting. The goal is to have the knowledge transferred to partner organizations within the project period (i.e. by 2013).

The installation procedure is site dependent. However, we always start with the monumentation of pillars. VSAT will be installed as soon as possible to establish Internet access. The installation of sensors is usually finished after 3 days, with an additional day for the commissioning of the station. If the station is installed without GFZ personnel, Internet access allows video guided help.

I understand that the here presented network of stations has a technical dimension but also involves aspects of development aid and practical application of the products. Although it is clear that the present manuscript is mainly dedicated to the first, I still miss a bit of background information on the second aspect.
Thereby I ask myself who owns and maintains the stations now and in the future?

The CAWa project as a contribution of the Government of Germany to the Berlin Process by a funding of the Federal Foreign Office aims on stipulating timely data exchange and improving the monitoring infrastructure where necessary.

Currently the stations are owned by GFZ. The intention is to hand over the hardware by end of 2013 to the NHMS. Frequent trainings for NHMS staff as part of the CAWa project will transfer knowledge. Already now, but more intense after 2013, the continuation of the network operation will be supported by GFZ's GCO-CA activities and by the Helmholtz Roadmap for Research Infrastructures (http://www.helmholtz.de/no_cache/mediathek/publikationen/pr/helmholtz-roadmap-for-research-infrastructure/)

Who uses the data at the moment and for what purposes? Again, this question might not be the main focus of the manuscript, but I believe the paper would benefit from a slightly clearer listing of the current (and maybe future) use of the data products. Closely related to this point is also the description of potential scientific use of the data products. The glaciological use of the Abramov station could be a bit more specific, and the same applies to the use as "ground truthing data for new space born monitoring techniques" (page 316, line 23) or the mentioned development of "early warning/multi hazard monitoring applications" (Page 316, line 8). I do not want to recommend a change in focus of the paper, but rather encourage the authors to clearer embed their detailed and valuable technical description in the context of real world applications.

We will extend section 5 in the revised version of this manuscript and give more details on potential applications.

As soon as the data will be integrated automatically into the data management systems of the NHMS in their standard coded format, the station data will be used for the operational tasks performed by the NHMS, such as weather forecast, seasonal runoff forecast.

Abramov Glacier was included in this paper as an example because this station demonstrates the application of the ROMPS concept beyond pure hydrometeorological monitoring. Beside this, the Abramov monitoring site with an altitude of 4100 m asl is one of the more extreme locations for continuous unattended monitoring. The camera information is used by the WGMS for their monitoring programme, the other sensor information is public.

A few missions for which ground truthing is needed are mentioned in the paper. ESA's CroySat-2 mission will also return SIRAL data for glacier areas. This will be supported with the Merzbacher station. EnMAP, the Environmental Mapping and Analysis Program mission, also needs in-situ observatories for calibration and validation. Last but not least, the GRACE and GRACE follow-on missions are depending on hydrometeorological data to validate gravity changes caused by changes in the water budget as well as changes in continental ice masses.

Adding early warning/multi hazard monitoring applications are already under way by providing seismological data. Our Merzbacher station is being extended for GLOF monitoring of Lake Merzbacher.

On the long-run, the time series will be used for climate assessments and assimilated into climate models.

Detailed Suggestions:
1. Page 302, lines 4–6: Maybe this sentence could be changed to: "Since 2009, GFZ and CAIAG, in cooperation with the National Hydrometeorological Services (NHMS) of Central Asia, are establishing such a regional monitoring network in Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan, and Afghanistan to collect observations of meteorological and hydrological parameters and to deliver them to the end-users."

Will be corrected in the revised version

2. Page 307, line 26: I am personally somewhat reluctant towards citing brief conference abstracts as these contain a very limited amount of information. The planned use of the camera pictures could be outlined more comprehensible by citing Corripio (2004) (description of a method to geo-reference oblique photography) and e.g. Rabatel et al. (2005) (one of the various studies applying remotely sensed snow lines as a proxy for glacier mass balance).

Will be corrected in the revised version

3. Page 315. line 11: Related to the point above: such an application would benefit from glaciological observations on the glacier. Are such observations carried out or do you refer to pre-1999 data?

In 2011, the team of WGMS / University of Fribourg (M. Hoelzle et al.) in cooperation with UzHydromet and CAIAG has setup ablation stakes and did re-measurements in 2012. This group is planning to continue the ablation measurements in the next year(s).

4. Page 315, line 11: To my opinion Kaser et al. (2003) is an inappropriate reference in this context. Please consider citing authors that specifically addressed the application of snow lines or equilibrium line altitudes to calculate glacier mass balance (e.g. Braithwaite, 1984; Rabatel et al., 2005; Jeanicke et al., 2006; Rabatel et al., 2008). A more common standard reference to mass balance observations using the glaciological method (stakes and snow pits) would be Østrem and Brugman (1991).

The reference list will be extended. A more recent paper (in print) will be added: Huss, M., Sold, L., Hoelzle, M., Stokvis, M., Salzmann, N., Daniel Farinotti, D., Zemp, M.: Towards remote monitoring of sub-seasonal glacier mass balance, Annals of Glaciology, 2012

5. Figures 1 and 8: I would strongly suggest merging these two figures into one. Thereby I would enlarge Figure 1 and show all the stations therein. On the one hand this would allow to shorten the manuscript. On the other hand, a combined figure would clearly show which stations are situated in high mountains and which stations are situated at somewhat lower elevations close to rivers (river discharge measurements). The information which countries are situated at the headwaters and which countries are located mostly downstream (given in Figure 8) can be omitted as it is not discussed nor mentioned in the text.

We will combine both figures.

6. Figure 9a: I have troubles finding the grey line denoting times where the input power exceeded current drain.

This will be corrected in the final version.

References

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G. Kaser, A. Fountain, and P. Jansson. A manual for monitoring the mass balance of mountain glaciers. Number 59 in IHP-VI, Technical Documents in Hydrology. UNESCO, Paris, 2003. URL http://unesdoc.unesco.org/images/0012/001295/129593e.pdf.
G. Østrem and M. Brugman. Glacier mass-balance measurements: a manual for field and office work. NHRI Science Report, 1991.
A. Rabatel, J-P. Dedieu, and C. Vincent. Using remote-sensing data to determine equilibrium-line altitude and mass-balance time series: validation on three French glaciers, 1994-2002.
Journal of Glaciology, 51(175):539–546, 2005.

In addition to our paper we are uploading two supplementary documents. The first is a (draft) version of the Site Exposure Description for each site. The second is the (internal) format description of our meteorological and hydrometeorological data. The format description document and the Site Exposure Description for all stations will be added to the extended SOPAF web page, which is being developed (sneak preview at http://cawa.gfz-potsdam.de:8080/SOPAF/SOPAF.html).

We thank the reviewer for the thorough discussion of our manuscript and the many useful comments which will certainly improve the final manuscript.